



Wind and turbulence at a forest edge

Dellwik, Ebba; Bingöl, Ferhat; Mann, Jakob; Sogachev, Andrey

Published in:
EWEC 2009 Proceedings online

Publication date:
2009

Document Version
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):
Dellwik, E., Bingöl, F., Mann, J., & Sogachev, A. (2009). Wind and turbulence at a forest edge. In *EWEC 2009 Proceedings online* EWEC.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Wind and turbulence at a forest edge

Ebba Dellwik, Ferhat Bingöl, Jakob Mann and Andrey Sogachev

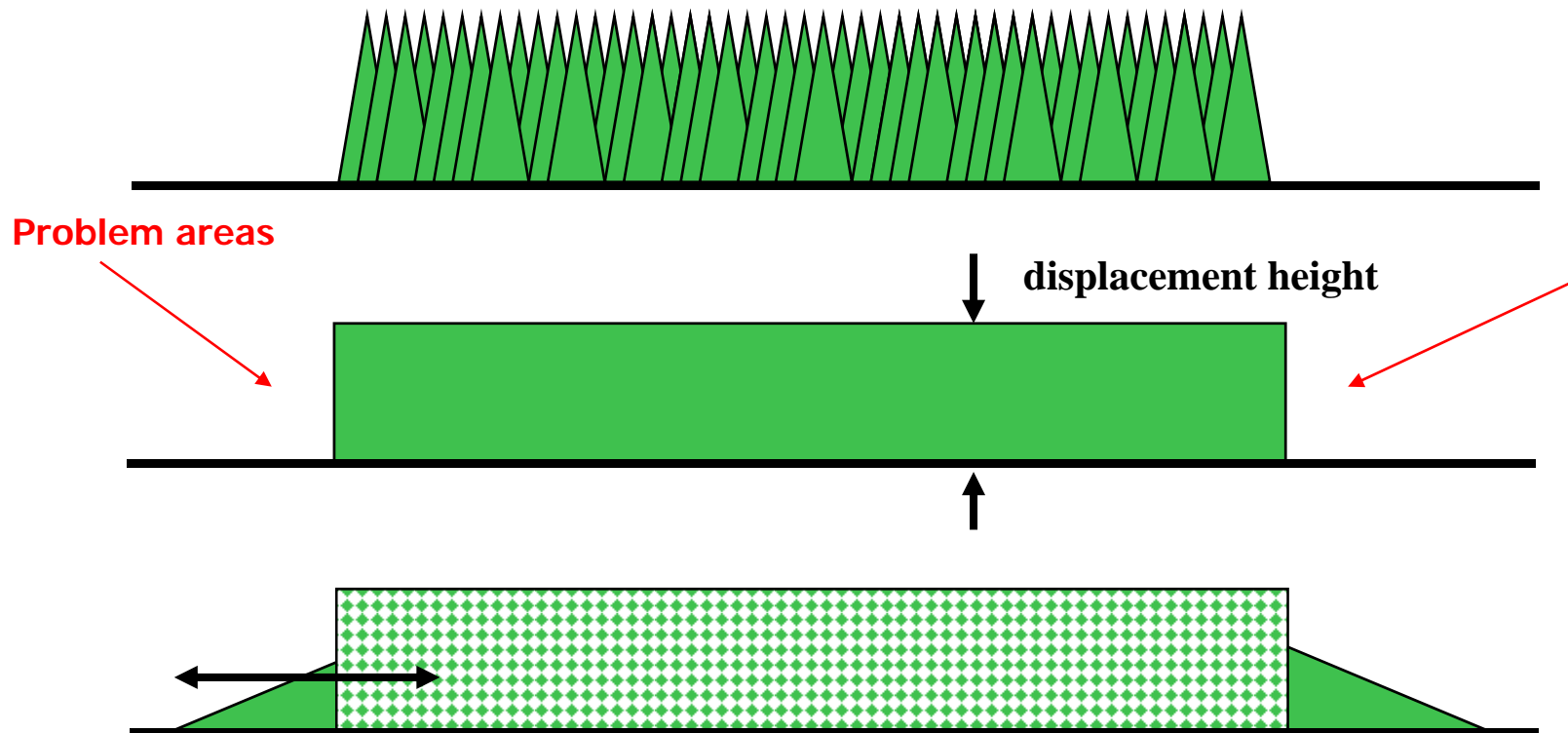
Wind Energy Division
Risø National Laboratory for Sustainable Energy
Danish Technical University

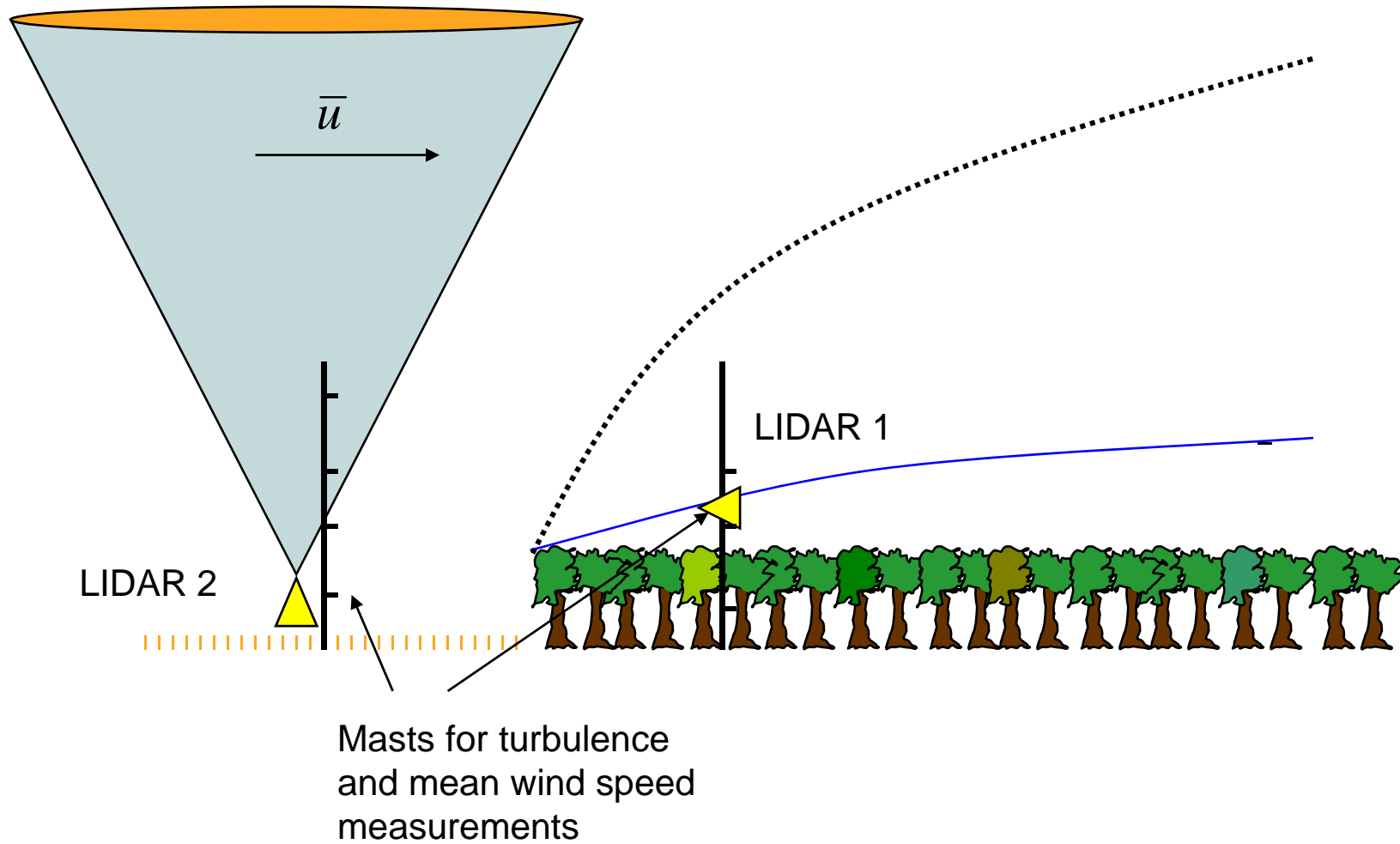
Outline

- Introduction to scientific goals and experiment.
- Mast and lidar data analysis at different atmospheric stability conditions.
- Modelling / model introduction.
- Preliminary WAsP Engineering solution.

How can the forest be parameterised in simple models?

Displacement height => Forest edge effects





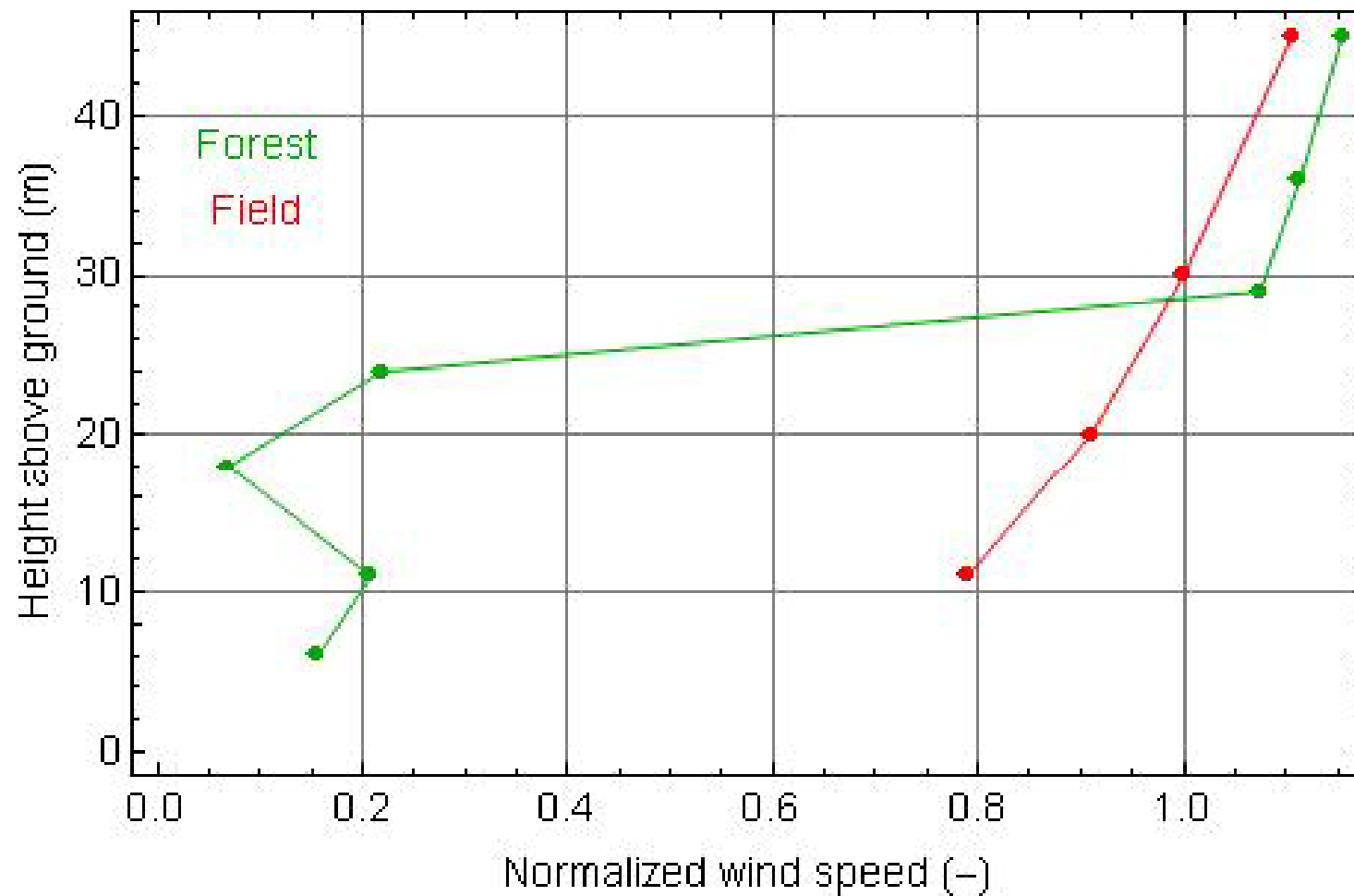
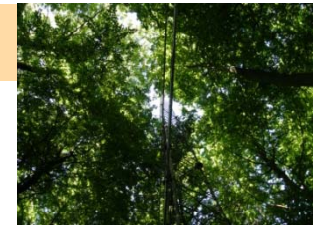




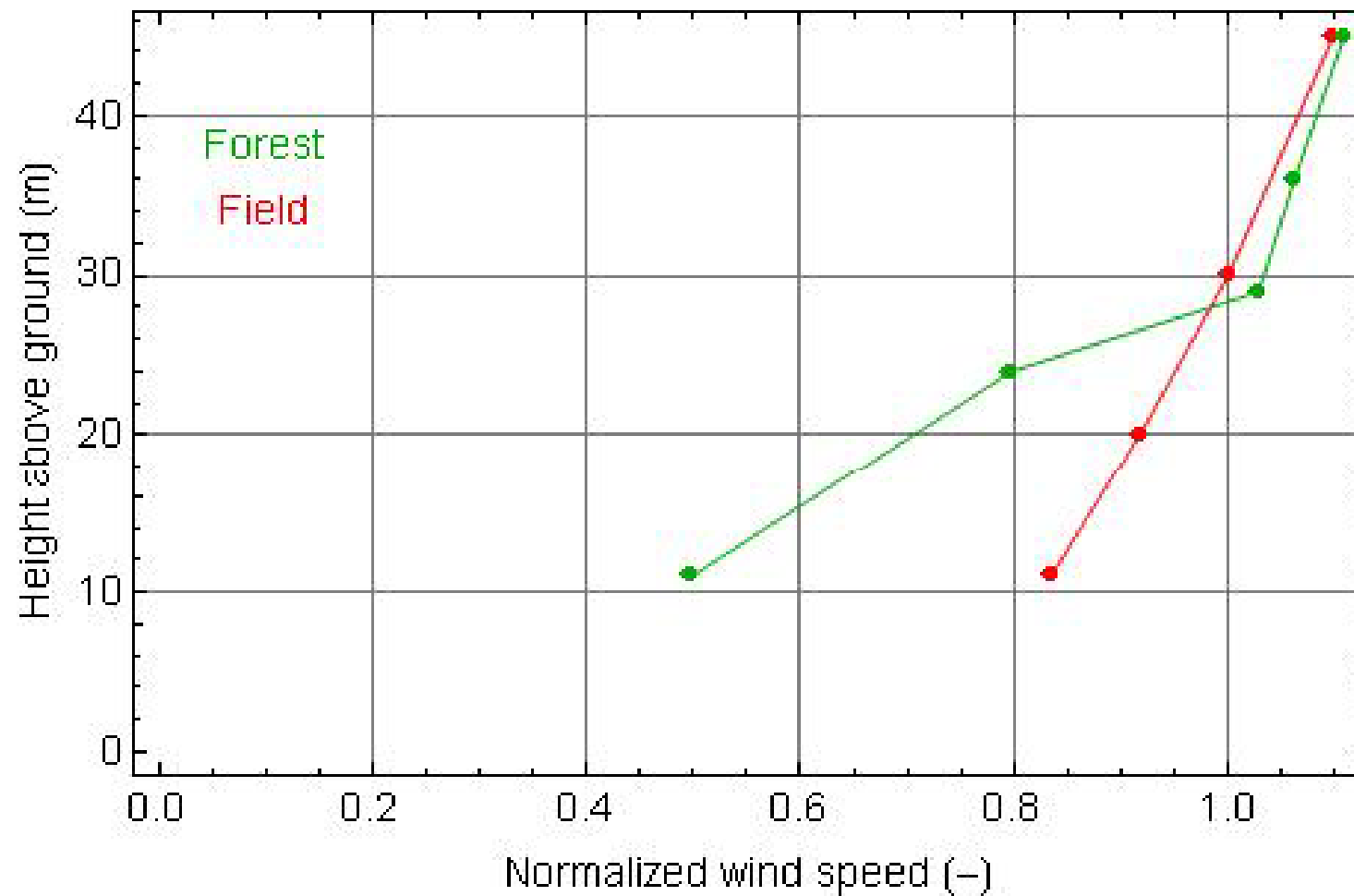




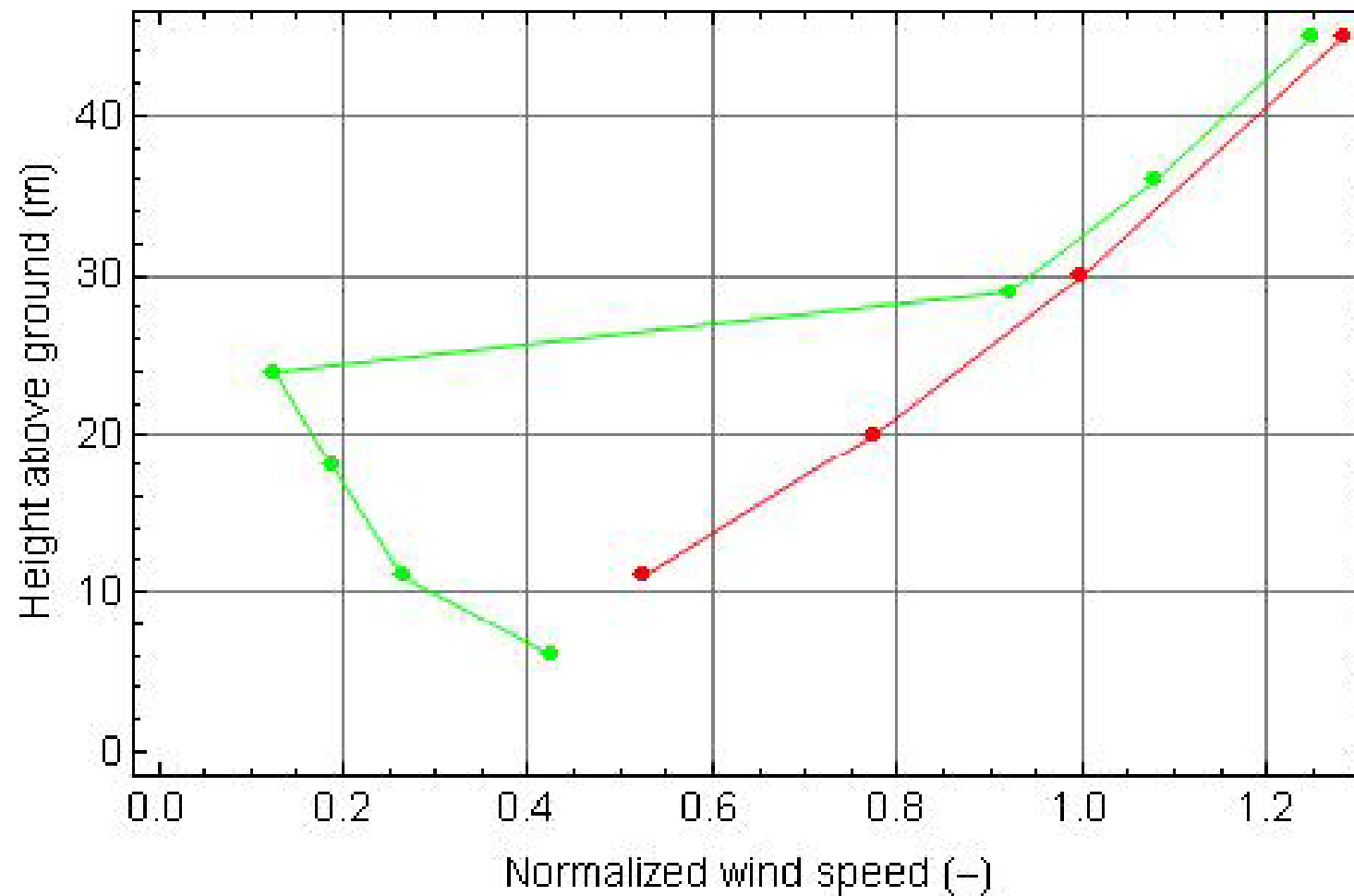
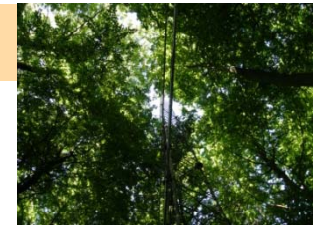
Mean wind speed – neutral stratification, summer



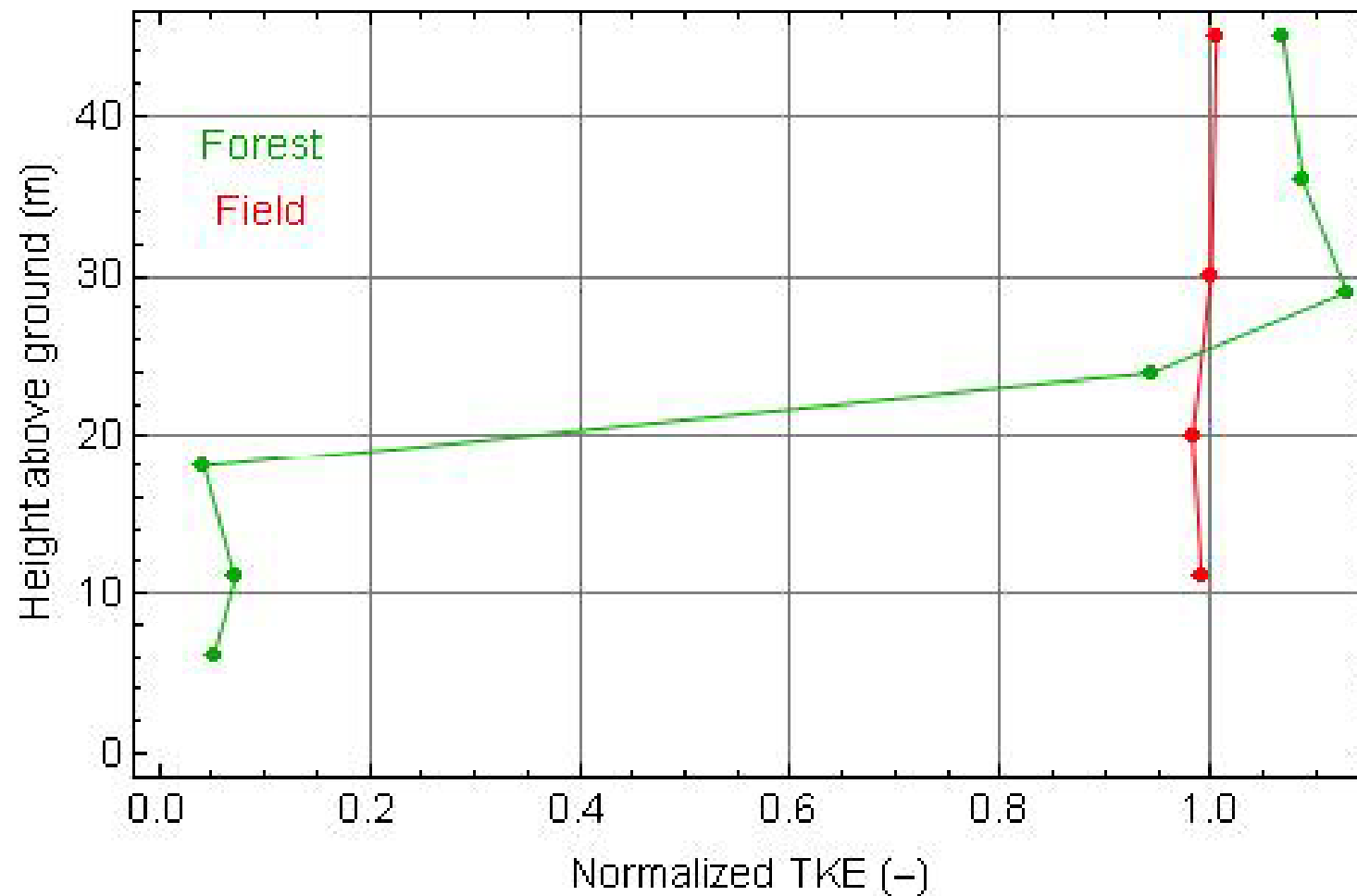
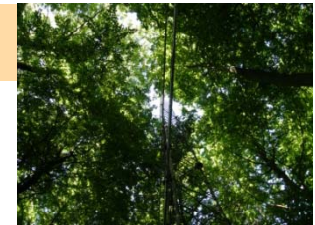
Mean wind speed – neutral stratification, winter



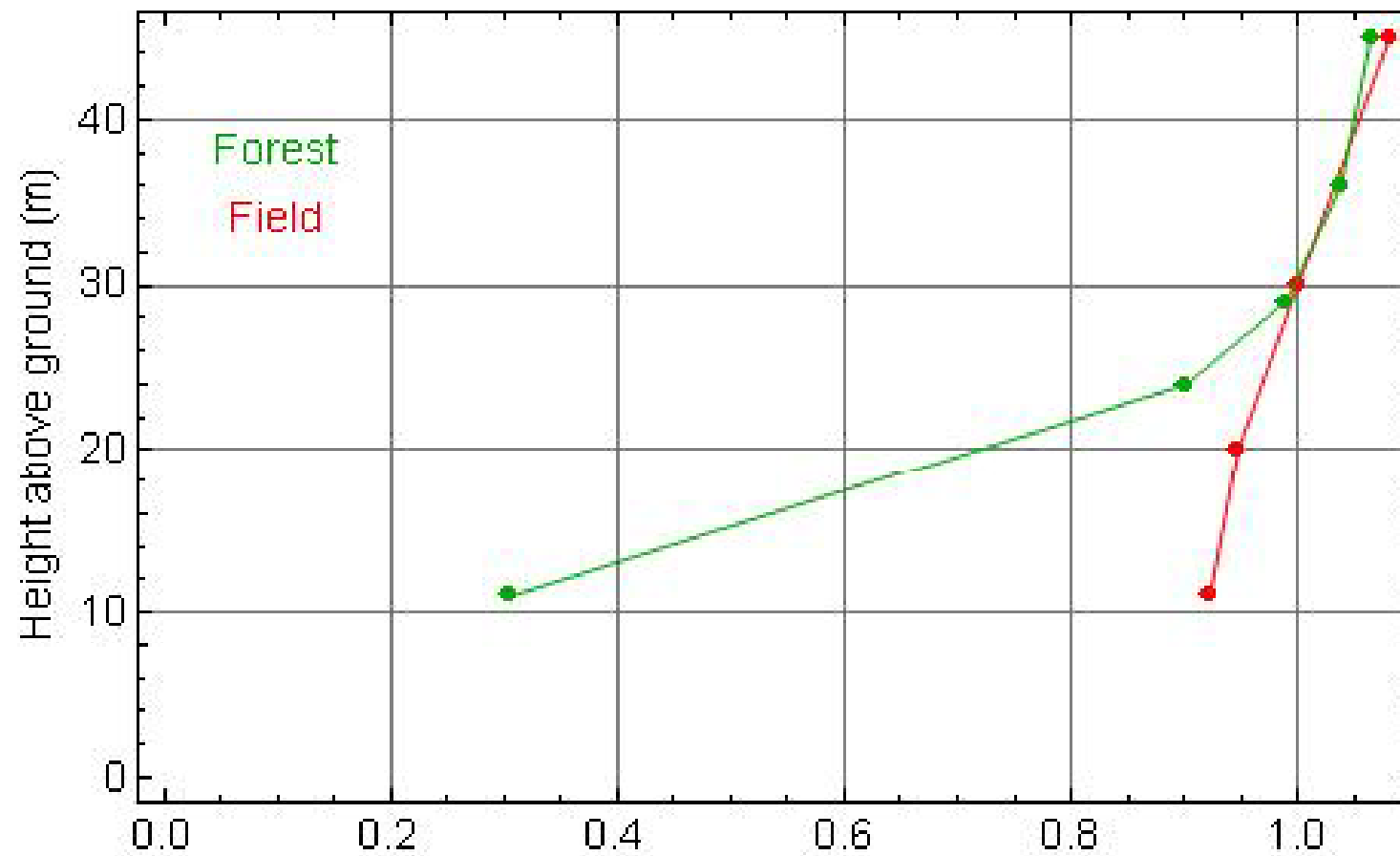
Mast data – stable stratification, summer

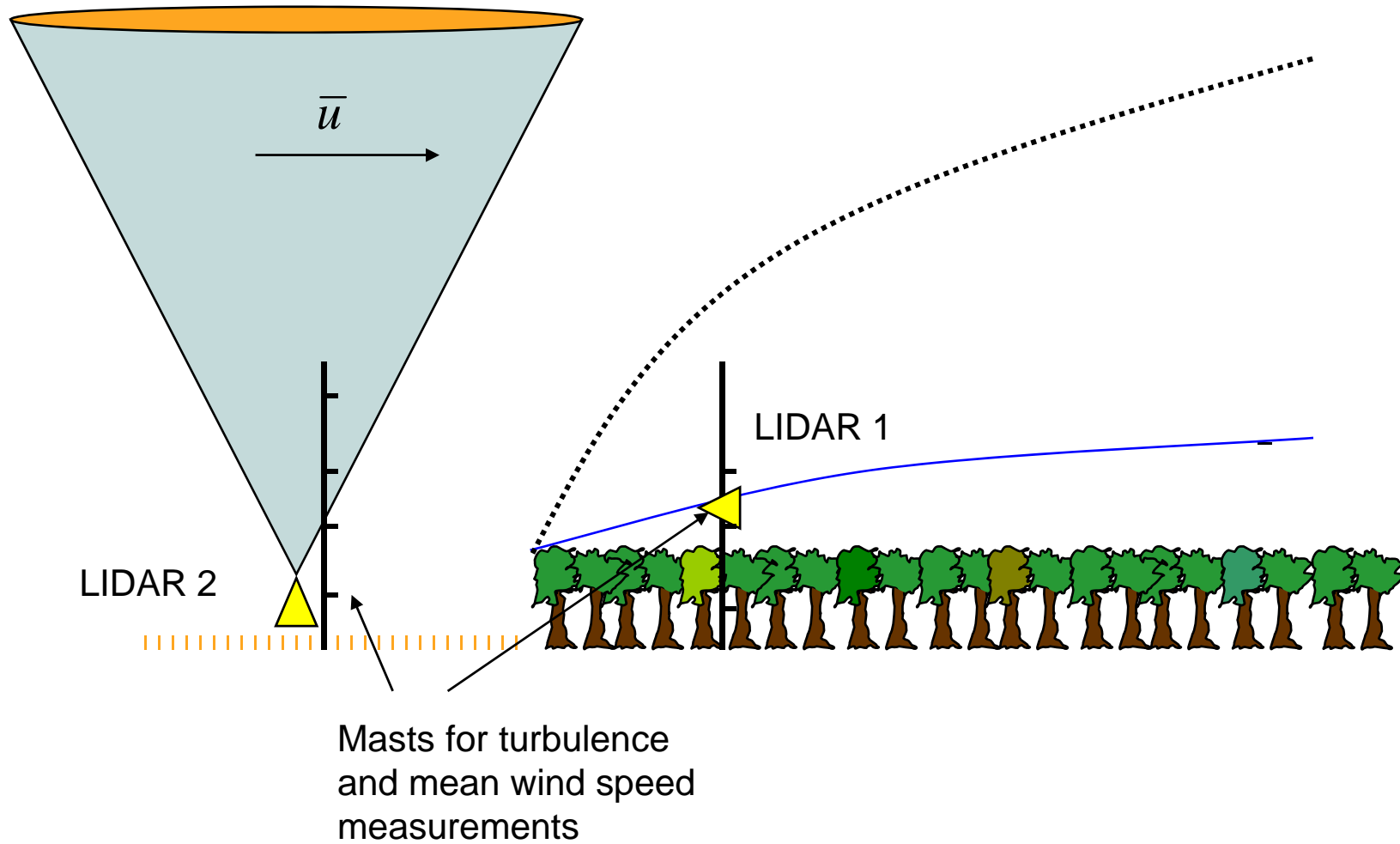


Turbulent kinetic energy – neutral, summer

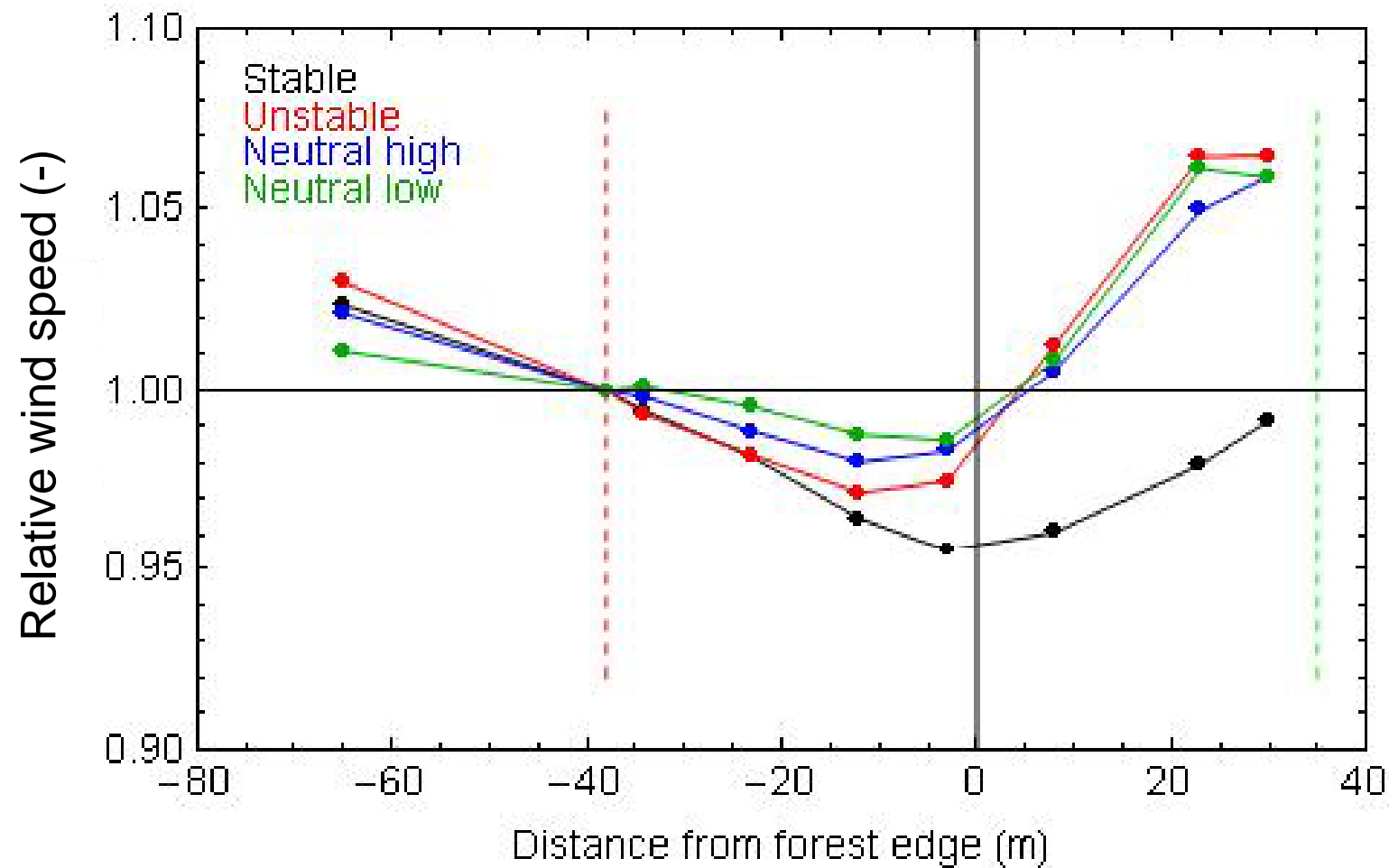


Turbulent kinetic energy – neutral, winter

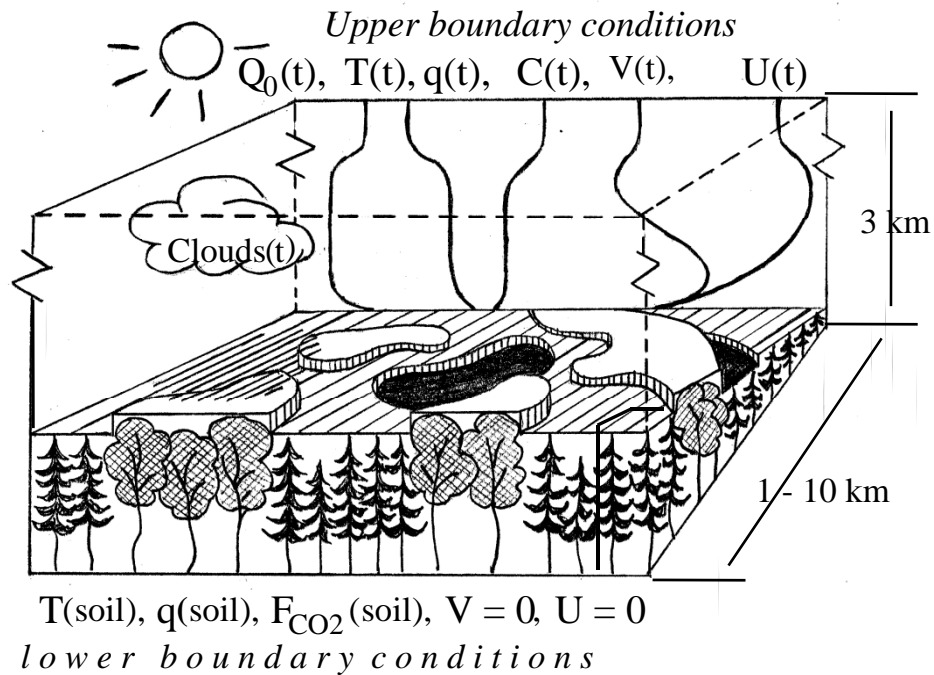




LIDAR horizontal scan @ 30m

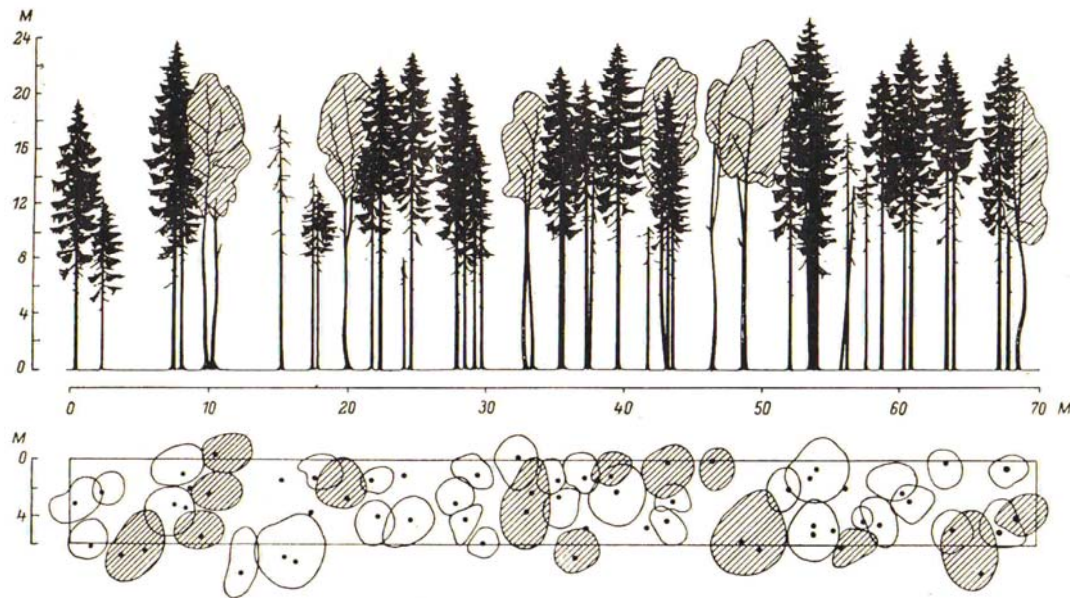


SCADIS



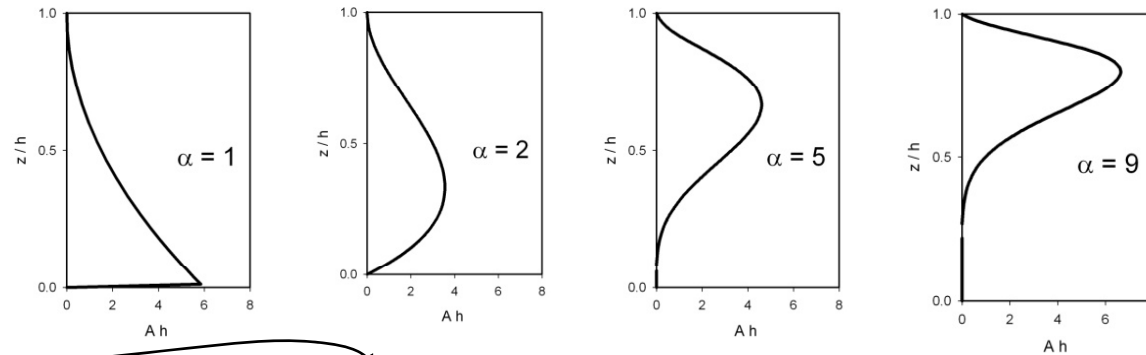
- Solves the RANS equations
- k-eps closure
- Enables detailed forest parameterisation
- Originally developed for environmental applications

Forest parameterisation



SCADIS forest parameterisation

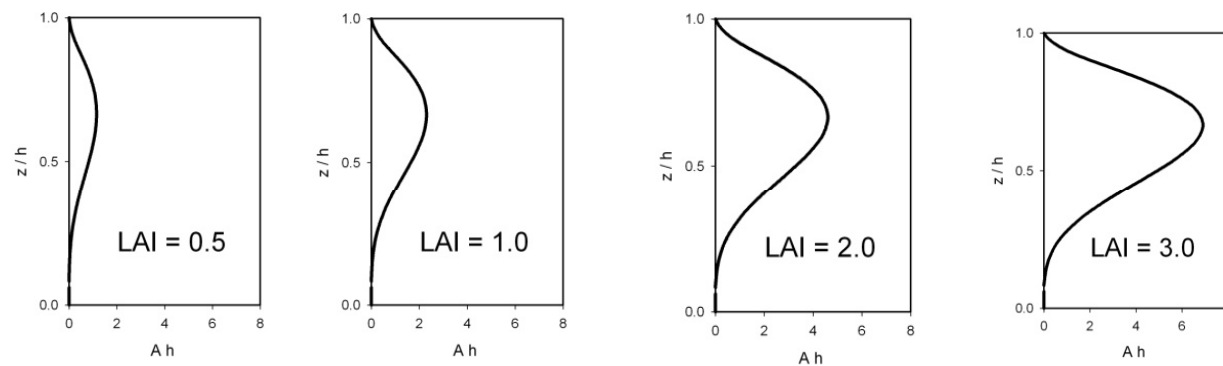
Forest type



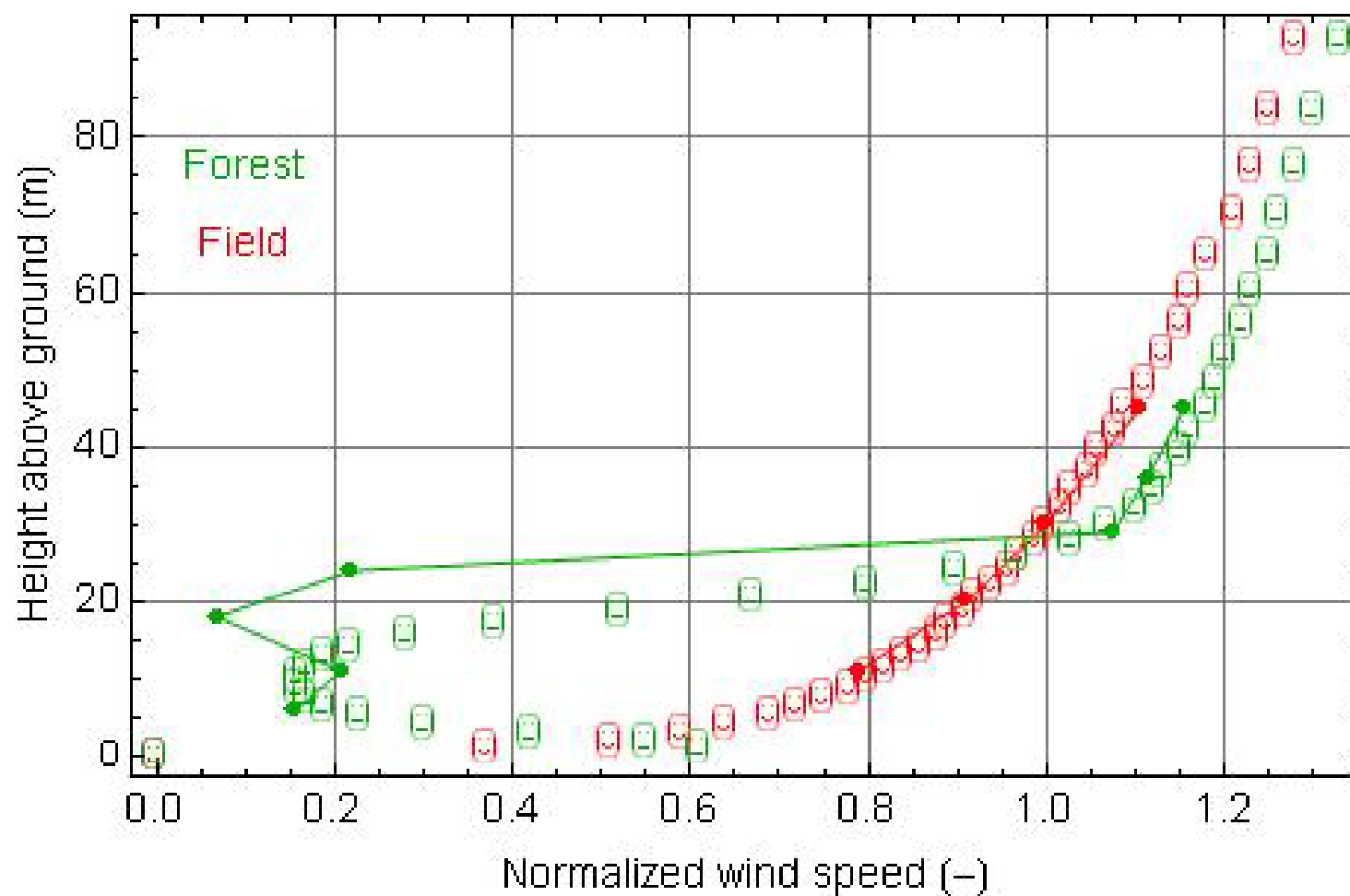
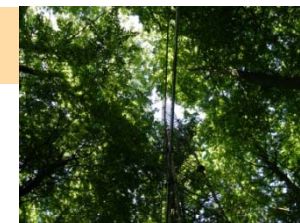
Drag force S:

$$S_i = -c_d \rho_{air} A(z) \bar{U}_i |U|$$

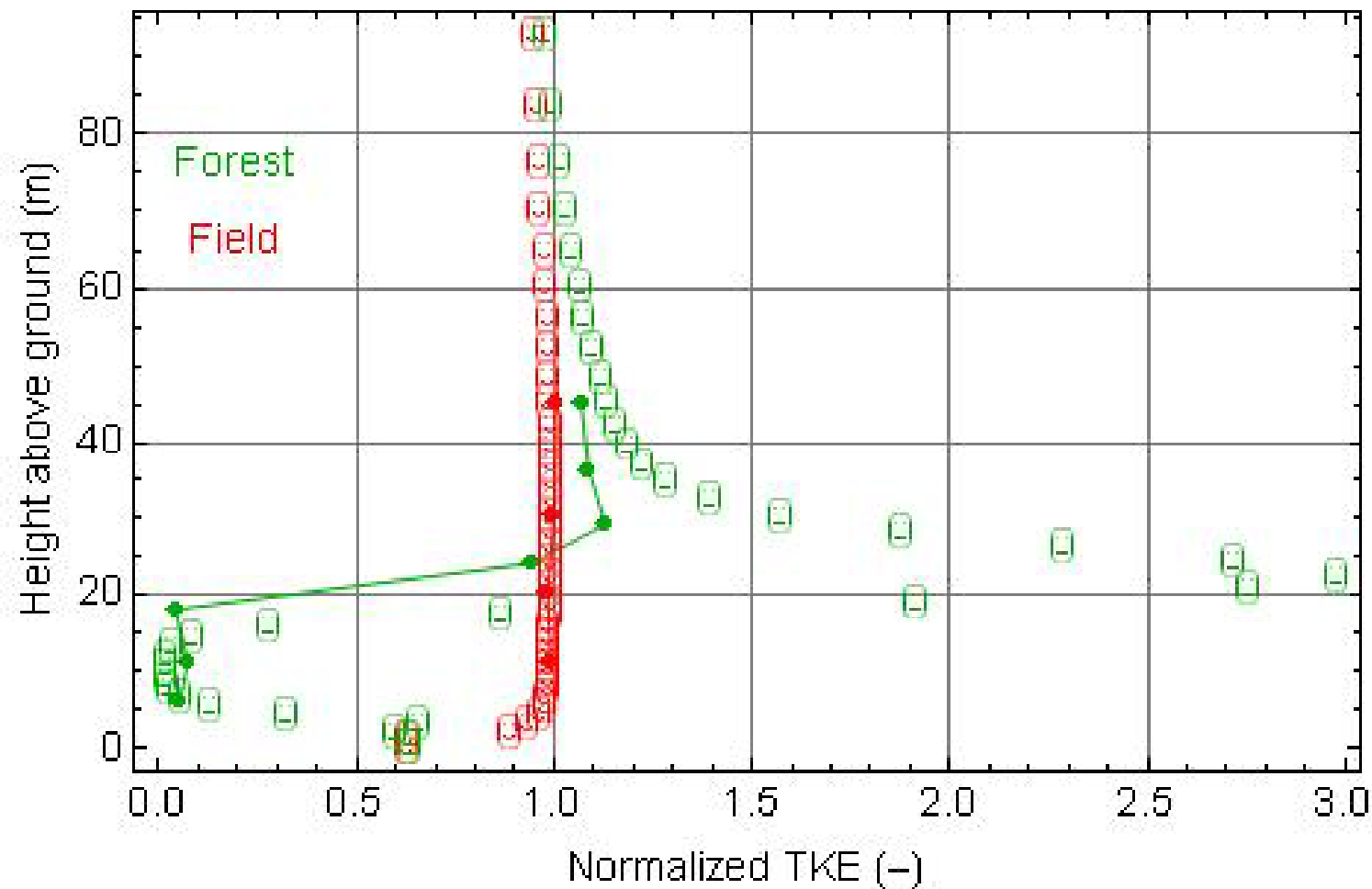
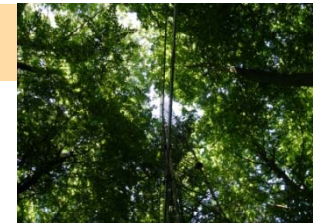
Forest density



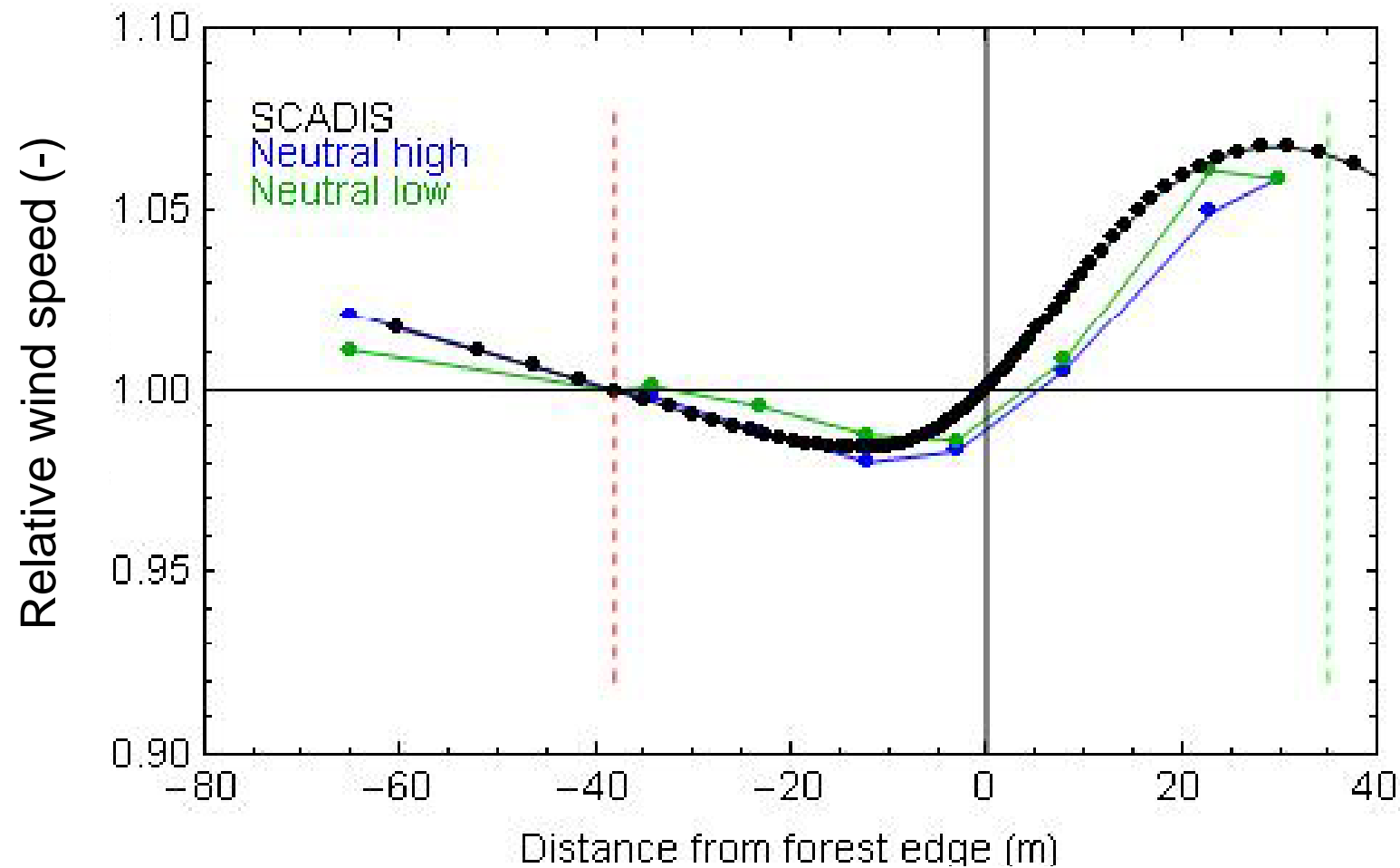
Mean wind speed – neutral, summer



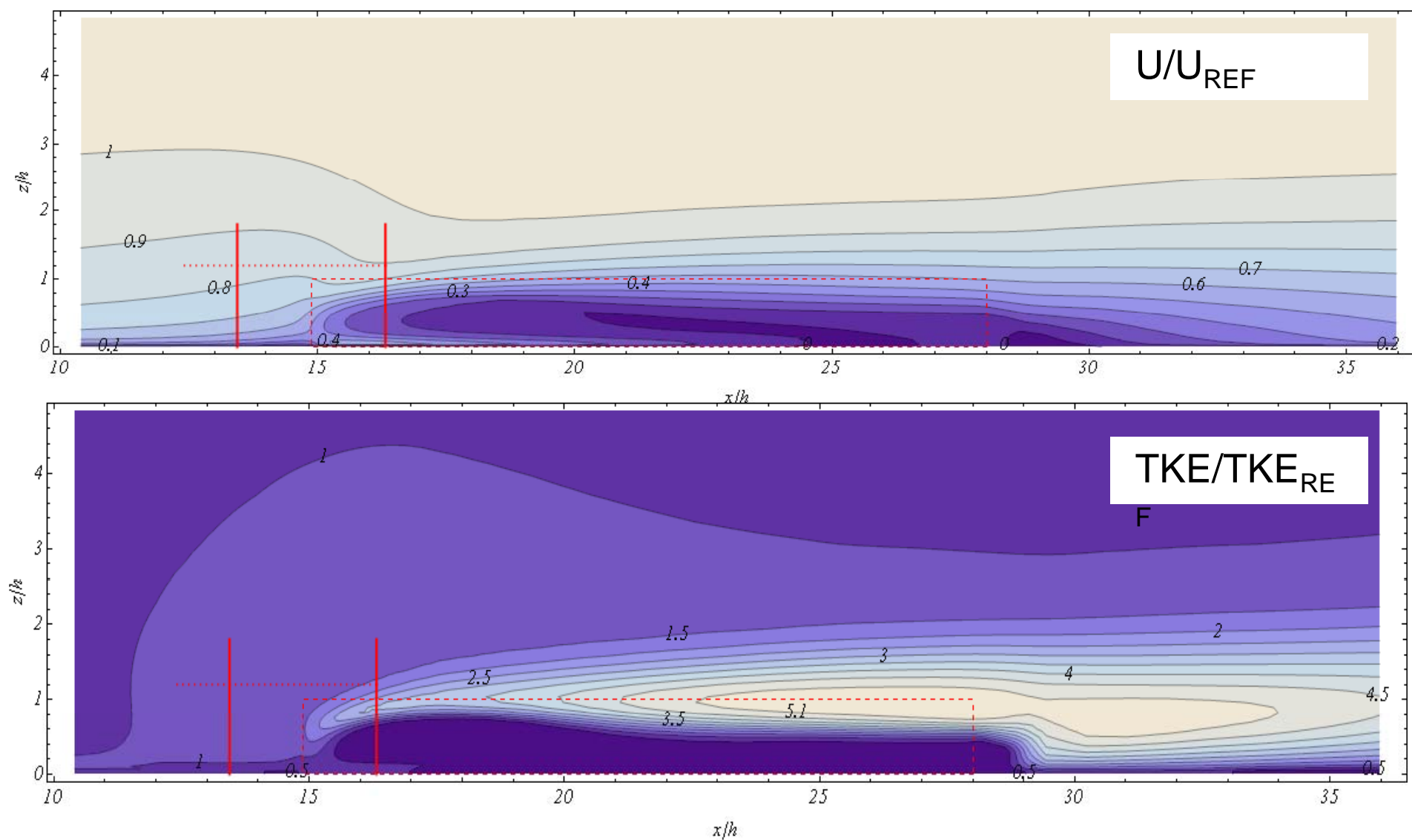
Turbulent Kinetic Energy – neutral, summer



Model-LIDAR comparison

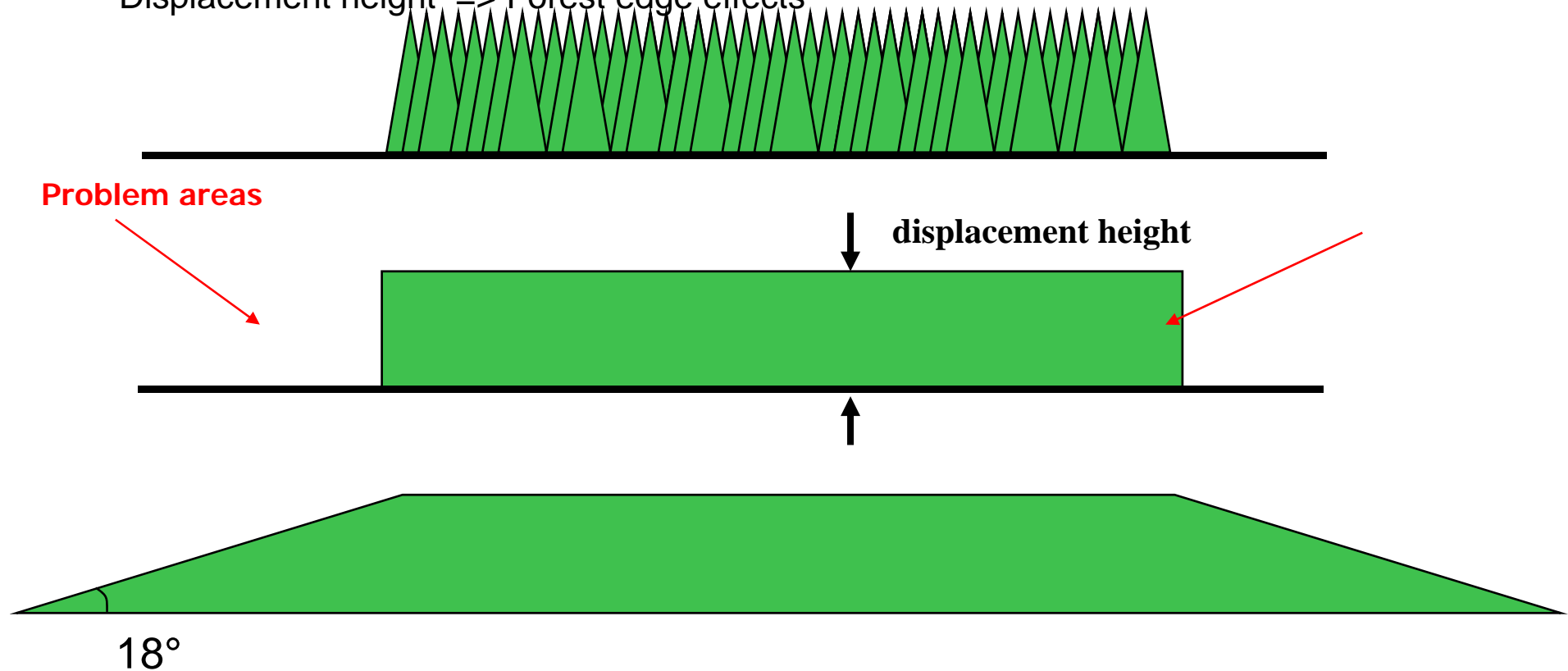


2D modelling results

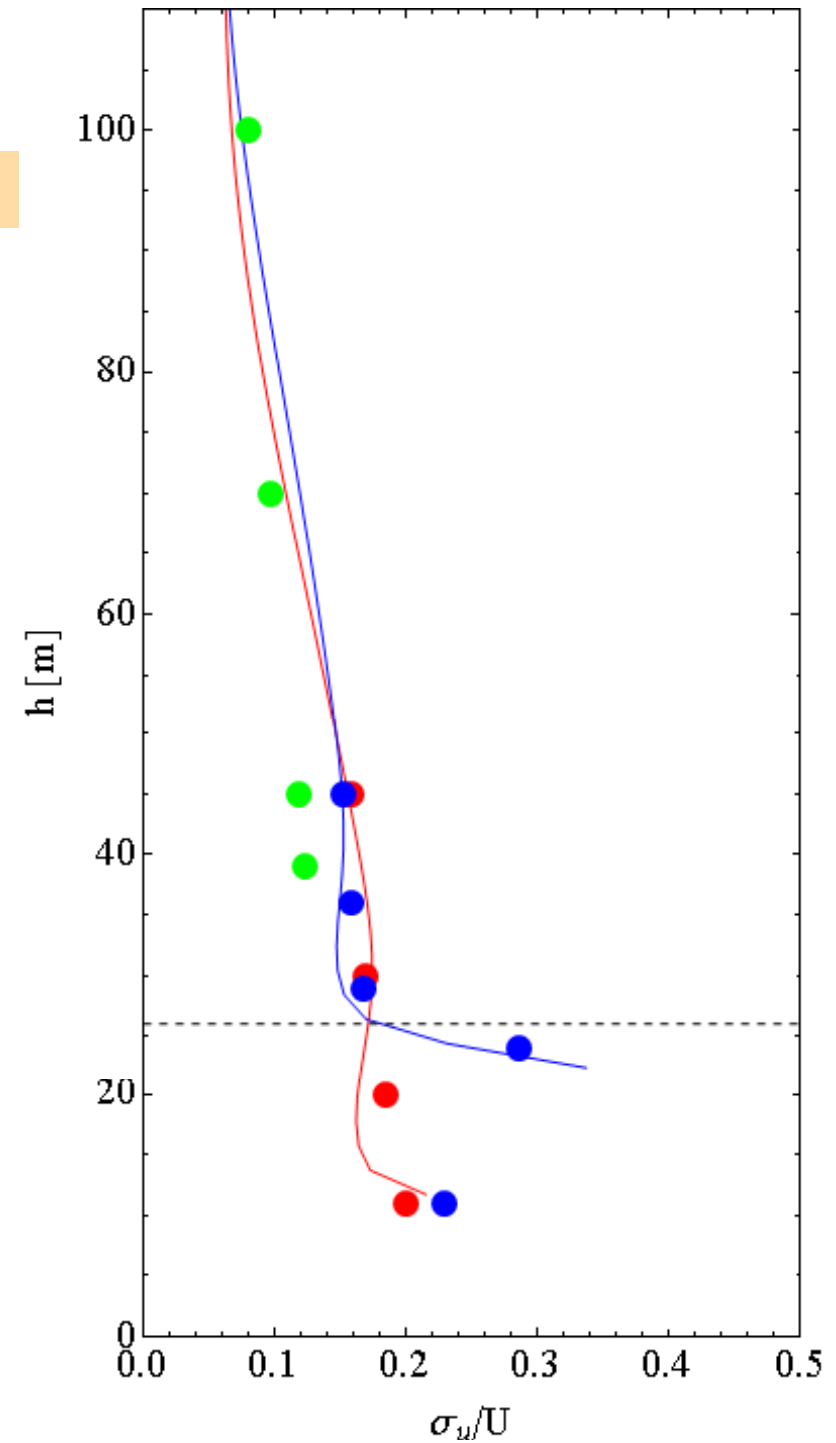


How can the forest be parameterised in simple models?

Displacement height => Forest edge effects



- Forest
- Field
- Conical scanning LIDAR



Conclusions

- The relative speed-up over the forest edge is dependent on the atmospheric stratification as well as the canopy density.
- At both mast positions, the wind field is affected by the forest edge.
- The SCADIS model can predict the flow speed-up over the edge.
- WAsP Engineering comparison shows that substituting the edge with a slope of 18 degrees is a good first approximation.
- Further analysis necessary to finalize recommendations for WAsP and WAsP Engineering.